

## Trigen Energy Corporation – Tulsa, Oklahoma

### Background

Trigen is a developer, owner, and operator of industrial, commercial, institutional, and district energy systems in North America. In 1989, Trigen purchased Tulsa's 19-year-old district heating and cooling facility from a local utility. The facility now provides steam for heating, cooling, and domestic hot water services for 32 commercial buildings (approximately one million square feet) in downtown Tulsa under a 20-year contract with the city. A 5-mile underground distribution network feeds steam and chilled water to buildings.

### Project Description

When Trigen purchased the facility, it consisted of a large steam turbine driving three centrifugal R-12 chillers with a total capacity of 16,700 tons. This system was coupled with three boilers, each with a capacity of 100,000 lbs/hr at 600 psig. Upon a closer study of the load profile, Trigen decided to replace part of the existing system with 200-ton screw chillers driven by a 1,200 kW gas turbine with an induction motor generator designed to match the chillers' specific electrical requirements. The base load system meets approximately 50 percent of the annual cooling load of the plant. Trigen supplemented this system by adding two smaller R-134 electric chillers with capacities of 1,000 and 2,000 tons respectively. To further improve boiler efficiency, Trigen channeled exhaust gas from the turbine to the boiler to be used as pre-heated inlet air.

The steam distribution network was upgraded by adding a backpressure steam turbine to replace an existing pressure reducing valve. Lowering the steam pressure from 600 psig to 150 psig through a backpressure turbine generates an additional 500 kW of electricity. Trigen-Tulsa currently sells 75 percent of electricity generated to the grid.

Trigen – Tulsa Plant Operating Data for 1999*	
Project Design Capacity (MW <sub>e</sub> )	17
Power to Heat Ratio	0.4
Total Net Efficiency (HHV)	77%
% Fuel Savings <sup>1</sup>	11% (1,400 metric tons of carbon)
Effective Electricity Efficiency (HHV) <sup>2</sup>	70%

*\*Data based on 8,760 annual hours of operation*

<sup>1</sup> Savings based on 50% efficient electric and 80% efficient thermal generation with natural gas as the primary fuel.

<sup>2</sup> Effective Electric Efficiency = (CHP power output)/(Total energy input to CHP system – total heat recovered/0.8). Assumes thermal output provided at 80% efficiency.

## Success Strategy

Trigen conducted a thorough study of the load profile at the district heating and cooling facility in order to determine technology additions to the system. This allowed the company to take advantage of most of the existing equipment in the facility, reducing capital investments. Efficiency improvements throughout the new system ensured further capacity gains for Trigen-Tulsa.

Signing a Real Time Pricing (RTP) agreement with the local electric utility further reduced costs. This allows the plant to switch from electric chillers, used during low RTP prices (off-peak period), to steam chillers during high RTP prices (summer peak period). An added benefit to the plant of this fuel-switching capacity was the increase in overall reliability.

## Benefits

Technology improvements also increased flexibility, allowed the plant to better match the load profile during periods of low demand, and reduced fuel use by 11 percent compared to separate heat and power. Aside from the economic advantages, technology and efficiency improvements at the plant substantially reduced emissions of CO<sub>2</sub>. Compared to separate heat and power generation, the system annually saves 99 million standard cubic feet of natural gas and emits 5,600 fewer tons of CO<sub>2</sub>. This is the equivalent of planting 1,500 acres of forest or offsetting the annual greenhouse gas emissions from 510 households.

In March 2000, the United States Environmental Protection Agency and the Department of Energy recognized the pollution prevention benefits of this CHP facility with an ENERGY STAR® CHP Award. For more information on ENERGY STAR® CHP awards, please click [here](#).